

Claims

1. A method for the continuous biocatalytic conversion of aqueous solutions containing biocatalytically convertible material in a reactor having one or more converting/degassing stages in parallel or serial interconnection, each converting/degassing stage comprising a bioreactor or two or more bioreactors and a degassing device or two or more degassing devices, where the bioreactor or the bioreactors and the degassing device or the degassing devices are in serial interconnection, and where in each converting/degassing stage in a first process step an aqueous solution containing biocatalytically convertible material is fed to the inlet of the bioreactor where it is contacted with a biocatalyst under formation of a biocatalytically converted solution containing at least one gas and at least one product, and where in a second process step the biocatalytically converted solution is transferred from an outlet of the bioreactor or a common outlet line of two or more bioreactors to an inlet of the degassing device or a common inlet line to two or more degassing devices, where it is at least partially degassed to form a degassed solution and at least part of the degassed solution leaving the outlet of the last degassing device or a common outlet of two or more last degassing devices in line, is fed to the inlet of the first bioreactor in line or to a common feeding line for the inlets of two or more first bioreactors, in a continuous flow.
2. Method according to claim 1, characterized in that the bioreactor is a stirred tank reactor or a column reactor or a fluidized bed reactor or a basket reactor or a plug flow reactor or a membrane filter reactor or a combination of two or more of the mentioned reactors.

3. Method according to claim 1 or 2, characterized in that the degassing device is a gas permeable membrane unit, a hydrocyclone or a flash tank or a combination of two or more of them.
- 5 4. Method according to one of claims 1 to 3, characterized in that the pressure at the inlet of the first bioreactor in line is 1,1 to 10 bar.
5. Method according to one of claims 1 to 4, characterized in that the converting/degassing stages are parallel interconnected.
- 10 6. Method according to one of claims 1 to 5, characterized in that the number of converting/degassing stages is 1 to 100
7. Method according to one of claims 1 to 6, characterized in that the biocatalytically converted solution is treated to remove insoluble solids from it before entering the degassing device.
- 15 8. Method according to one of claims 1 to 7, characterized in that the temperature of the solution is adjusted after one or more degassing stages in a heat exchanger.
- 20 9. Method according to one of claims claim 1 to 8, characterized in that the biocatalyst is immobilized on a carrier
- 25 10. Method according to one of claims 1 to 9, characterized in that the biocatalyst is yeast.

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11. Method according to one of claims 1 to 10, characterized in that the aqueous solution containing biocatalytically convertible material is wort.
- 5 12. Method according to one of claims 1 to 11 characterized in that the solution is green beer.
13. Apparatus for the continuous biocatalytic conversion of aqueous solutions containing biocatalytically convertible material comprising:
- 10 - a bioreactor or two or more bioreactors loaded with at least one biocatalyst, each bioreactor having at least one inlet and at least one outlet,
- a circuit line having an entrance connected with at least one outlet of at least one bioreactor via at least one device for degassing the aqueous solution, and at least one exit connected with at least one inlet of at least one bioreactor via a device for circulating the aqueous solution,
- 15 - at least one feeding line connected to the circuit line at a location downstream of the device for circulating the aqueous solution, and
- 20 - at least one outlet (withdrawal line) connected to the circuit line at a location upstream of the device (4) for circulating the aqueous solution.
14. Apparatus according to claim 13 comprising at least two bioreactors (1) in a serial interconnection.
- 25 15. Apparatus according to claim 14 comprising at least two bioreactors (1) in a parallel interconnection.

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16. Apparatus according to one of claims 13 to 15, characterized in that it comprises two or more converting/degassing stages.
- 5 17. Apparatus according to one of claims claim 13 to 16, characterized in that at least one bioreactor (1) is a stirred tank reactor, a fluidized bed reactor, a basket reactor, a plug flow reactor, or a membrane filter reactor.
- 10 18. Apparatus according to one of claims 13 to 17, characterized in that at least one degassing device (3) is a gas permeable unit, a hydrocyclone, or a flash tank.
- 15 19. Apparatus according to one of claims 13 to 18 further comprising at least one device (2) for removing solids, having a discharge line (8) for removed solids, positioned in said circuit line upstream or downstream of a bioreactor (1).
- 20 20. Apparatus according to claim 9, characterized in that at least one device (2) for removing solids comprises at least one centrifuge or filter.
21. Apparatus according to claim 20, characterized in that the device (2) for removing solids comprises a disc stack centrifuge.
22. Apparatus according to one of claims 13 to 21 further comprising at least one heat exchanger (5).
- 25 23. Apparatus according to claim 22, characterized in that the at least one heat exchanger (5) is positioned at a location downstream of the degassing device (3).